

A TWO MICRON POLARIZATION SURVEY TOWARD DARK CLOUDS

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A near-infrared (2.2 μm) polarization survey of about 190 sources has been conducted toward nearby dark clouds. The sample includes both background field stars and embedded young stellar objects. The aim of the project is (i) to determine the magnetic field structure in the densest regions of the dark clouds and study the role of magnetic fields in various phases of star formation processes, and (ii) to study the grain alignment efficiency in the dark cloud cores.

From the polarization of background field stars and intrinsically unpolarized embedded sources, we have determined the magnetic field structure in these clouds. In Heiles Cloud 2, the Rho Oph core, and the NGC 1333 region, the observed intracloud polarization vectors are coincident in direction with the optical polarization in the outer regions of the clouds and are well aligned in a direction perpendicular to the long axis of the cloud elongation. These suggest that the magnetic field lines are smoothly connected from the outer regions to the inner regions of the clouds and run perpendicular to the major axis of these denser regions of the clouds. Thus, these clouds might have formed by contraction along the magnetic field, resulting in the flattened shape. On the other hand, in some regions in the clouds, like the L1641 as a part of the Orion A cloud complex and the Rho Oph streamers, the clouds are elongated roughly parallel to the magnetic field. These regions are relatively tenuous compared to the Ori BN/KL region and the Rho Oph core, respectively. This might be due to an expansion/flowing of matter along the magnetic field lines. Polarization efficiency ($P(K)/A_v$) ranges from 0.06 to 0.33 %mag⁻¹.

From the intrinsic polarization of young stellar objects, we have determined the spatial distribution of circumstellar dust around young stars. A remarkable perpendicularity has been found between the ambient magnetic field and the infrared polarization of young stellar objects which exhibit mass outflow phenomena. This indicated the presence of circumstellar disk/torus whose plane is perpendicular to the ambient magnetic field; the mass outflows expand in the polar regions of the disk and the polarization arises in the direction parallel to the disk plane due to scattering by dust grains in the reflection nebulaosity. The relationship is clearly seen in the NGC 1333 cloud, the Taurus cloud, and even L1641.

Combining the perpendicularity between the disks and magnetic fields with perpendicularity between the cloud elongation and magnetic fields, we conclude that the magnetic fields might have dominated nearly all aspects of cloud dynamics, from the initial collapse of the clouds right through to the formation of disks/tori around young stars in these low-to-intermediate mass star forming clouds of the Taurus, Ophiuchus, and Perseus. Although such geometrical relationship is less clear in the Orion cloud where high-mass stars are forming, the geometry of circumstellar structure might be also preferentially determined by the magnetic field in the clouds.

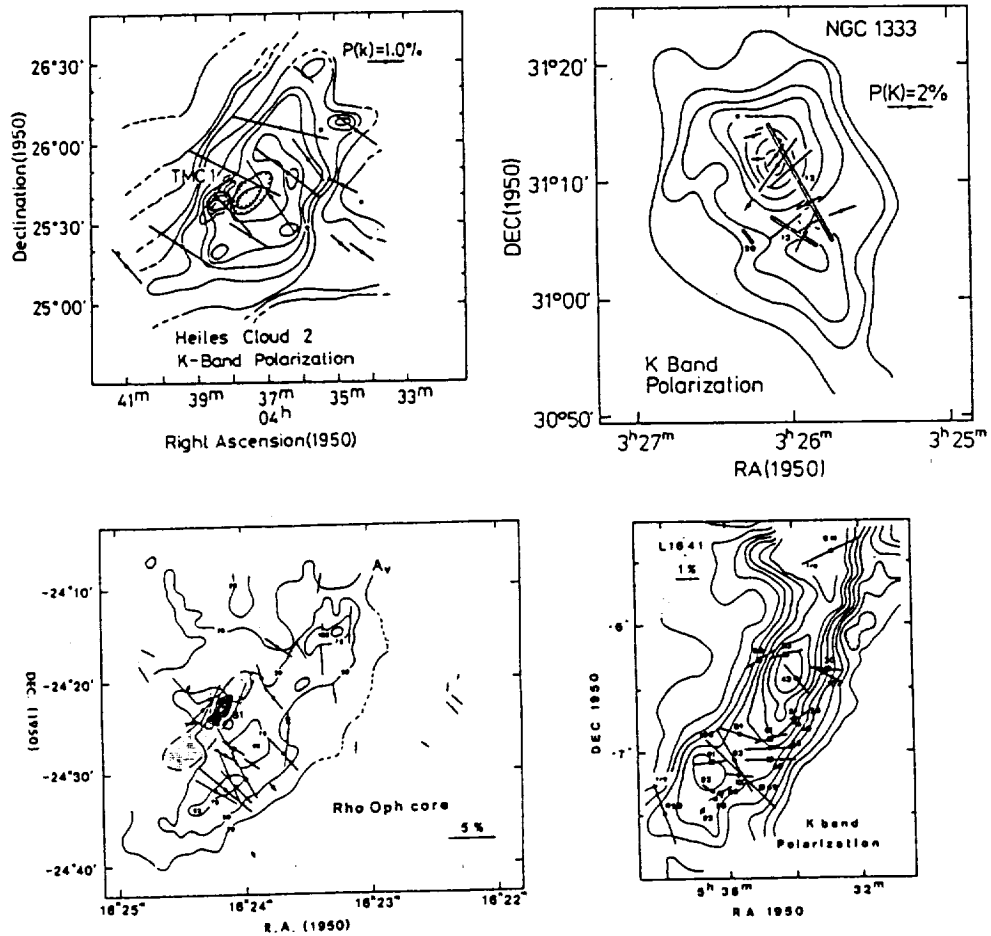


Fig. 1. 2.2 micron polarization maps of Heiles Cloud 2, the Rho Oph core, the NGC 1333 cloud, and L1641 superposed on the A_V or CO line contour maps.

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